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(54) **CAPSULE FOR TWO DOWNHOLE PUMP MODULES**

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(22) Filed: **May 17, 2007**

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(51) **Int. Cl.**
F04B 35/00 (2006.01)
E21B 43/00 (2006.01)

(52) **U.S. Cl.** **417/423.3**; 417/423.2; 417/423.5; 166/105; 166/105.5; 166/369

(58) **Field of Classification Search** 166/105, 166/105.5, 369, 370, 372, 380; 417/42.3, 417/244, 423.3, 423.5, 424.1, 426
See application file for complete search history.

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(57) **ABSTRACT**

Upstream and downstream pump assemblies are mounted in a capsule having a bulkhead between the upstream and downstream pump assemblies, dividing the capsule into upstream and downstream chambers sealed from each other. In a dual operation mode, well fluid flows through the inlet of the capsule into the upstream chamber, where it is pumped to a first pressure level by the upstream pump assembly and discharged into the downstream chamber. The downstream pump assembly then pumps the well fluid to a second pressure level and discharges the well fluid out the outlet of the capsule. The assembly has also an upstream pump assembly only operational mode and a downstream pump assembly only operational mode.

19 Claims, 4 Drawing Sheets

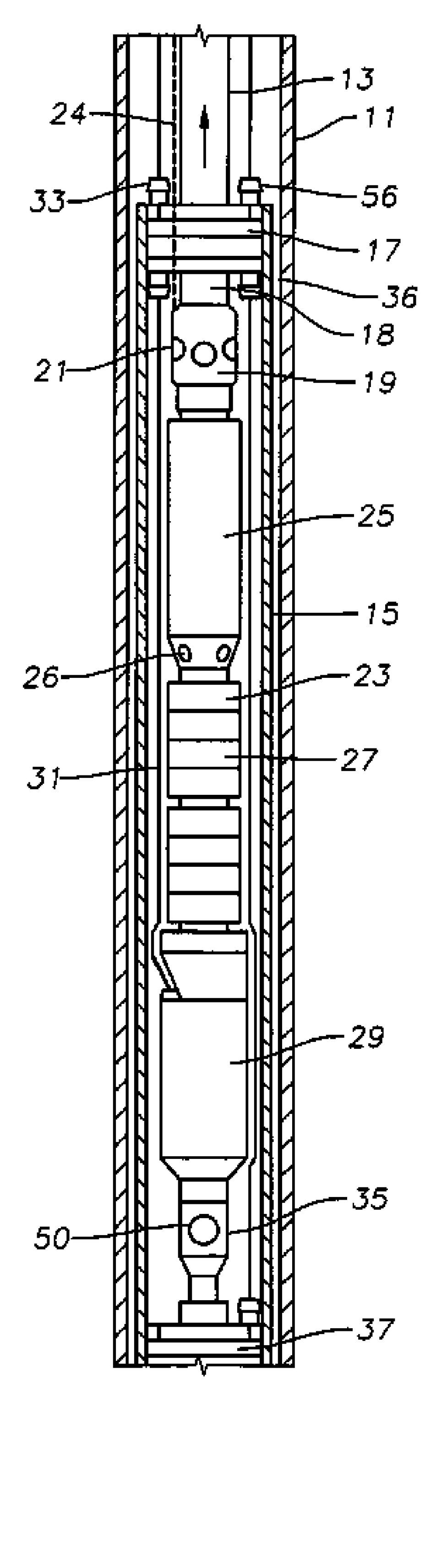

Fig. 1A

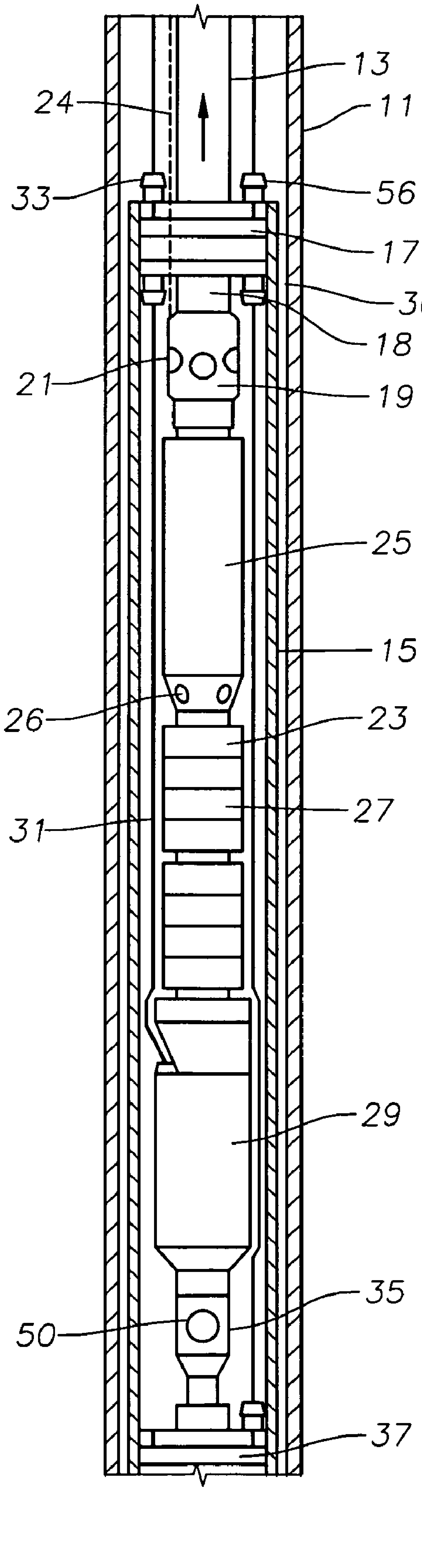
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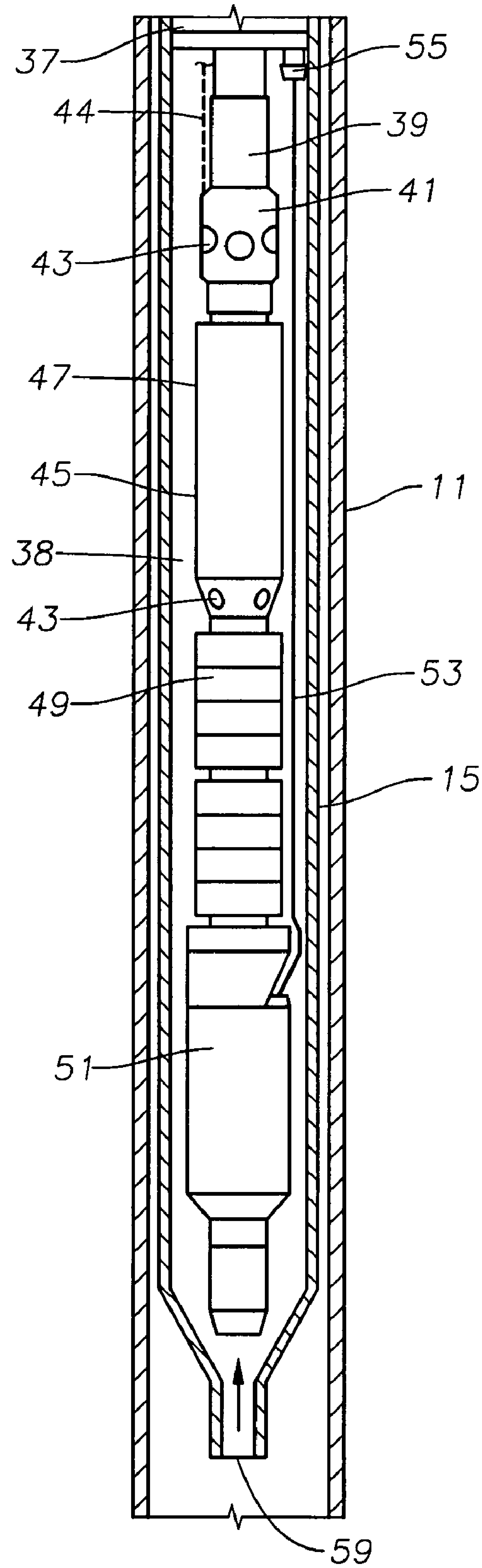
Fig. 1B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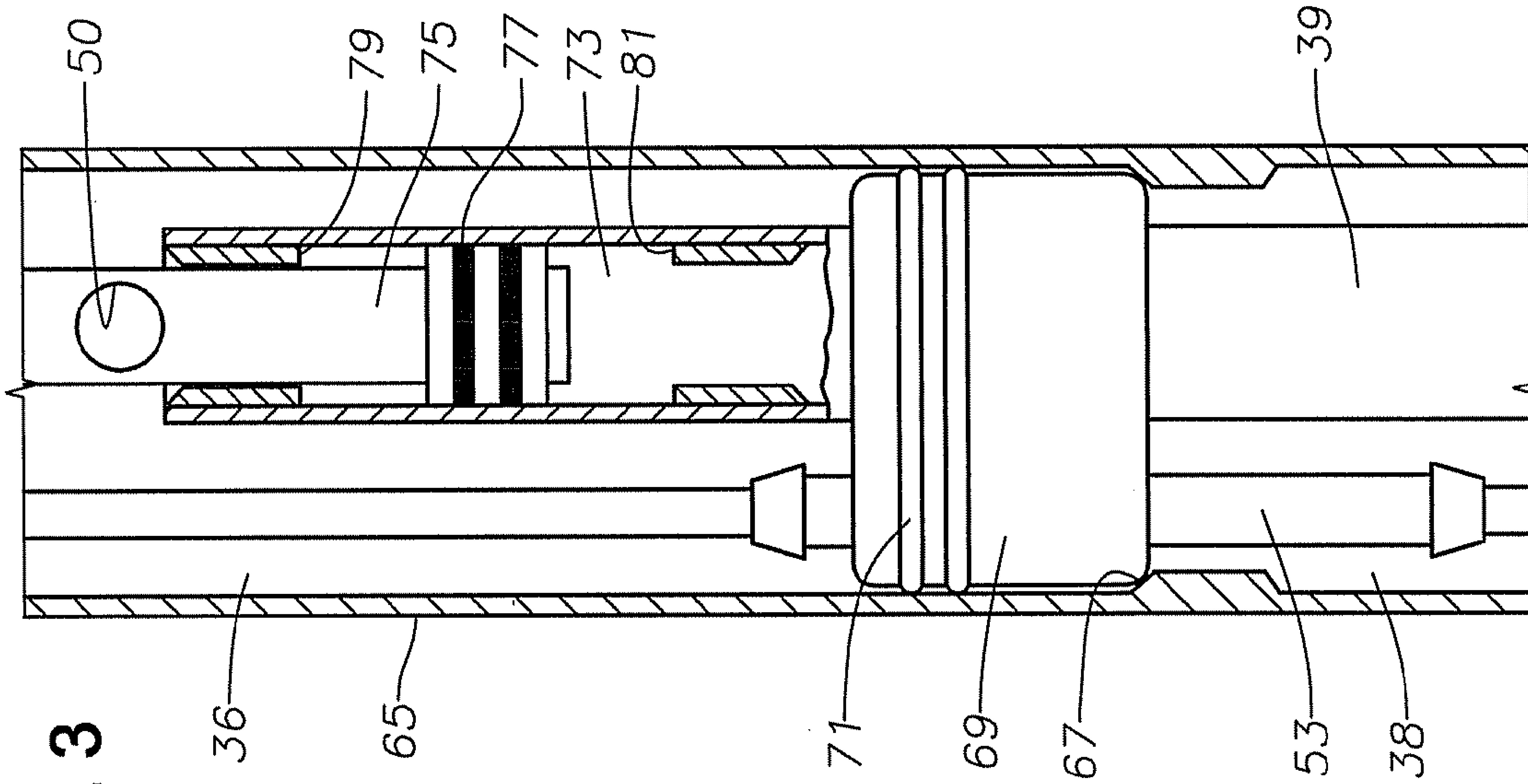
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Fig. 3

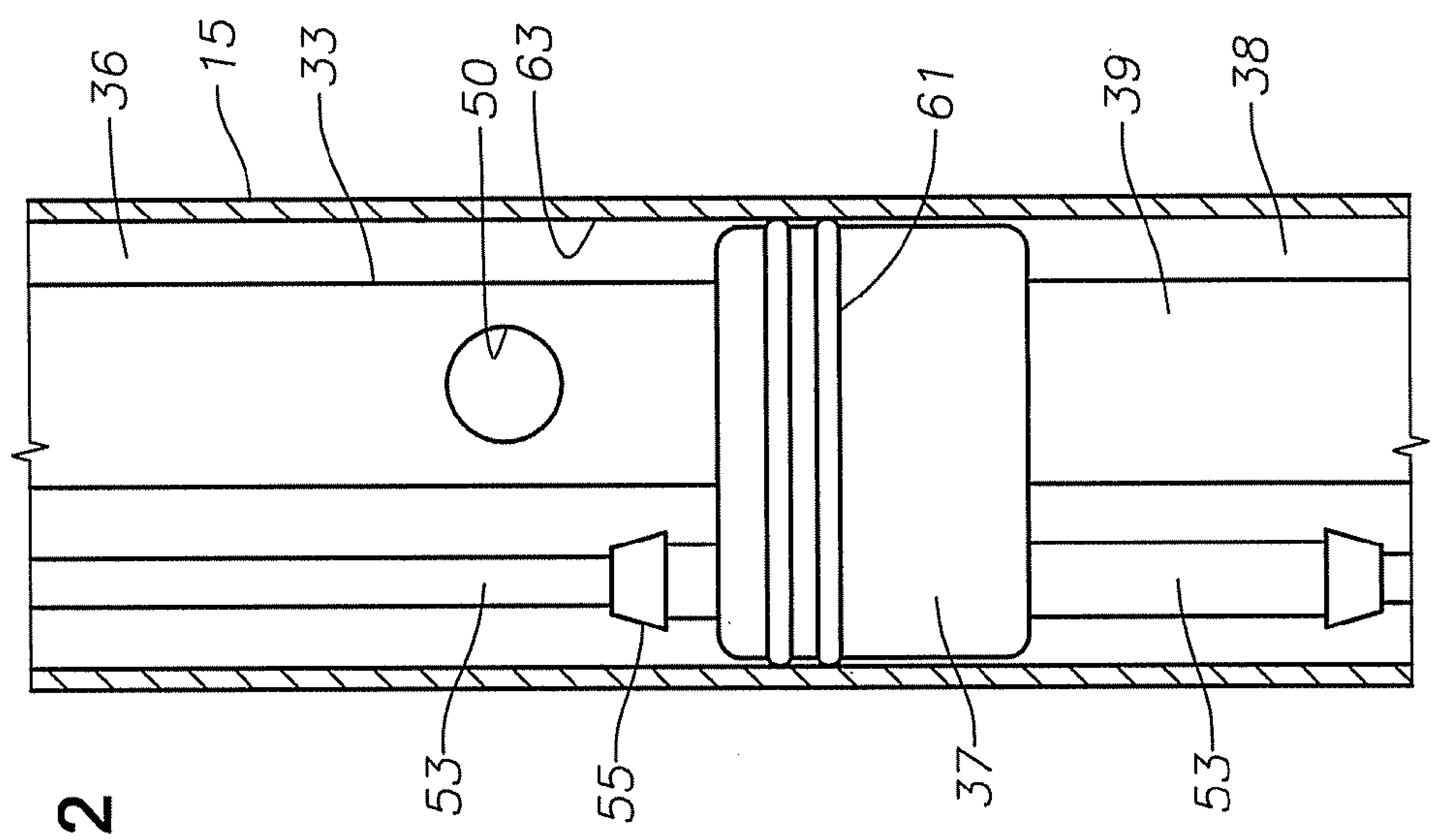
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Fig. 2

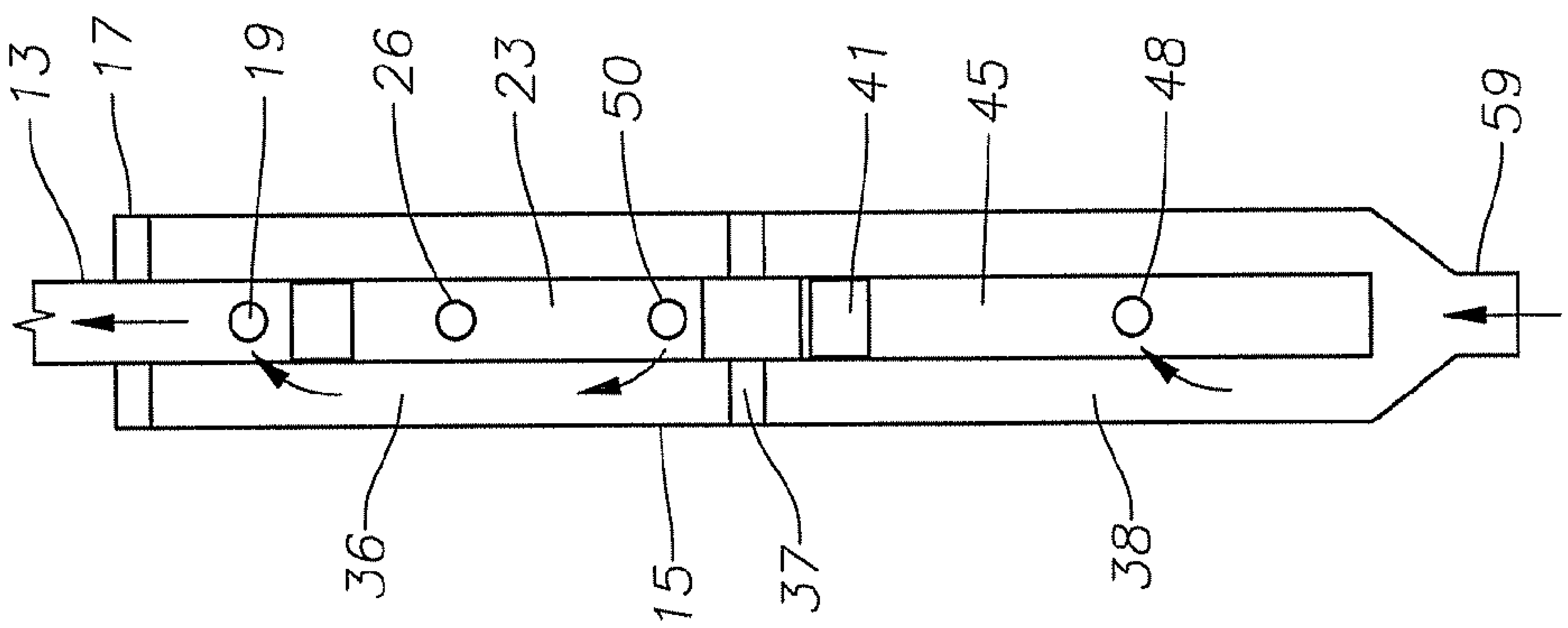

Fig. 6

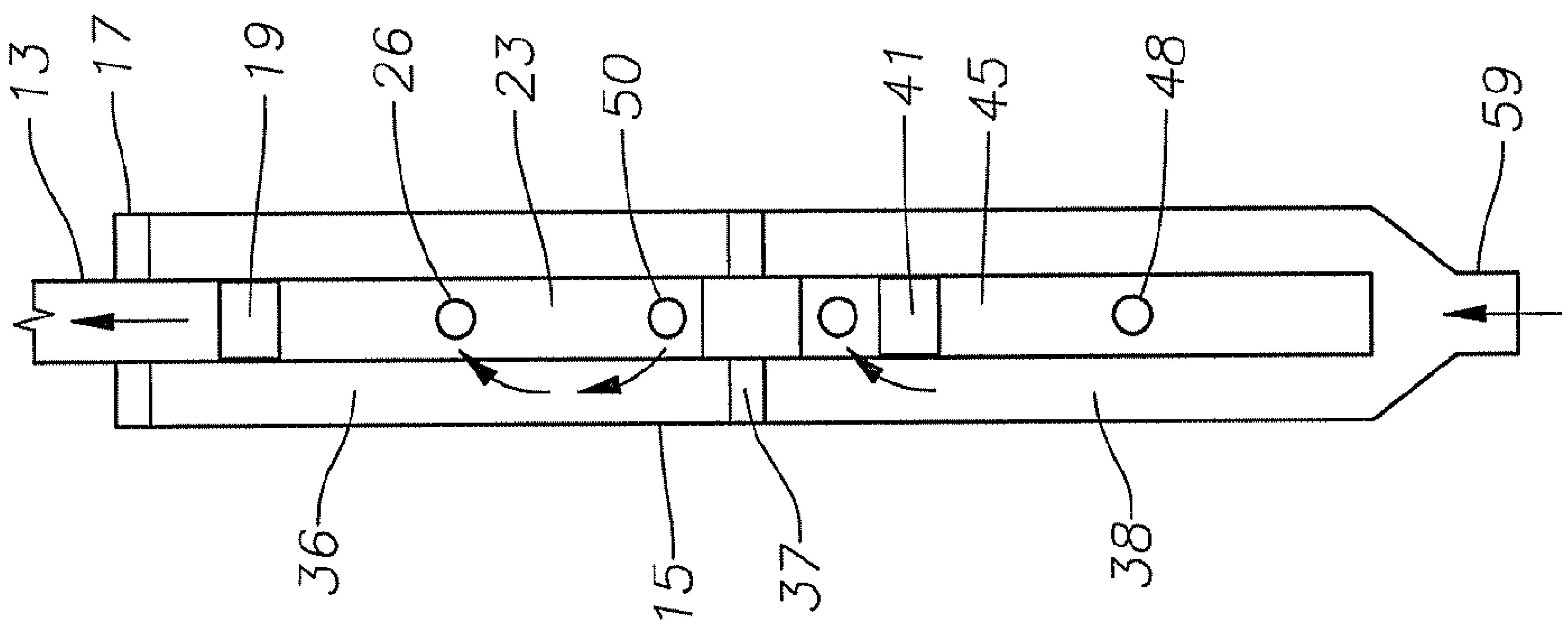

Fig. 5

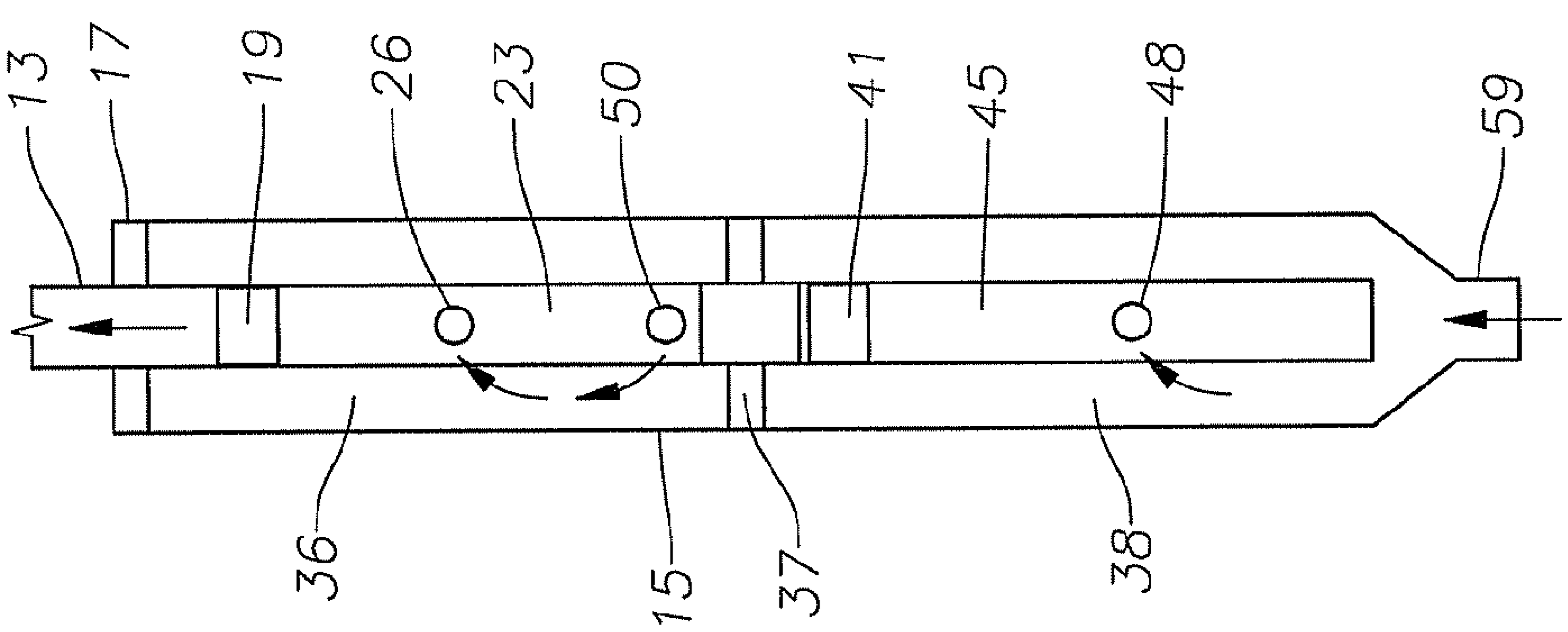

Fig. 4

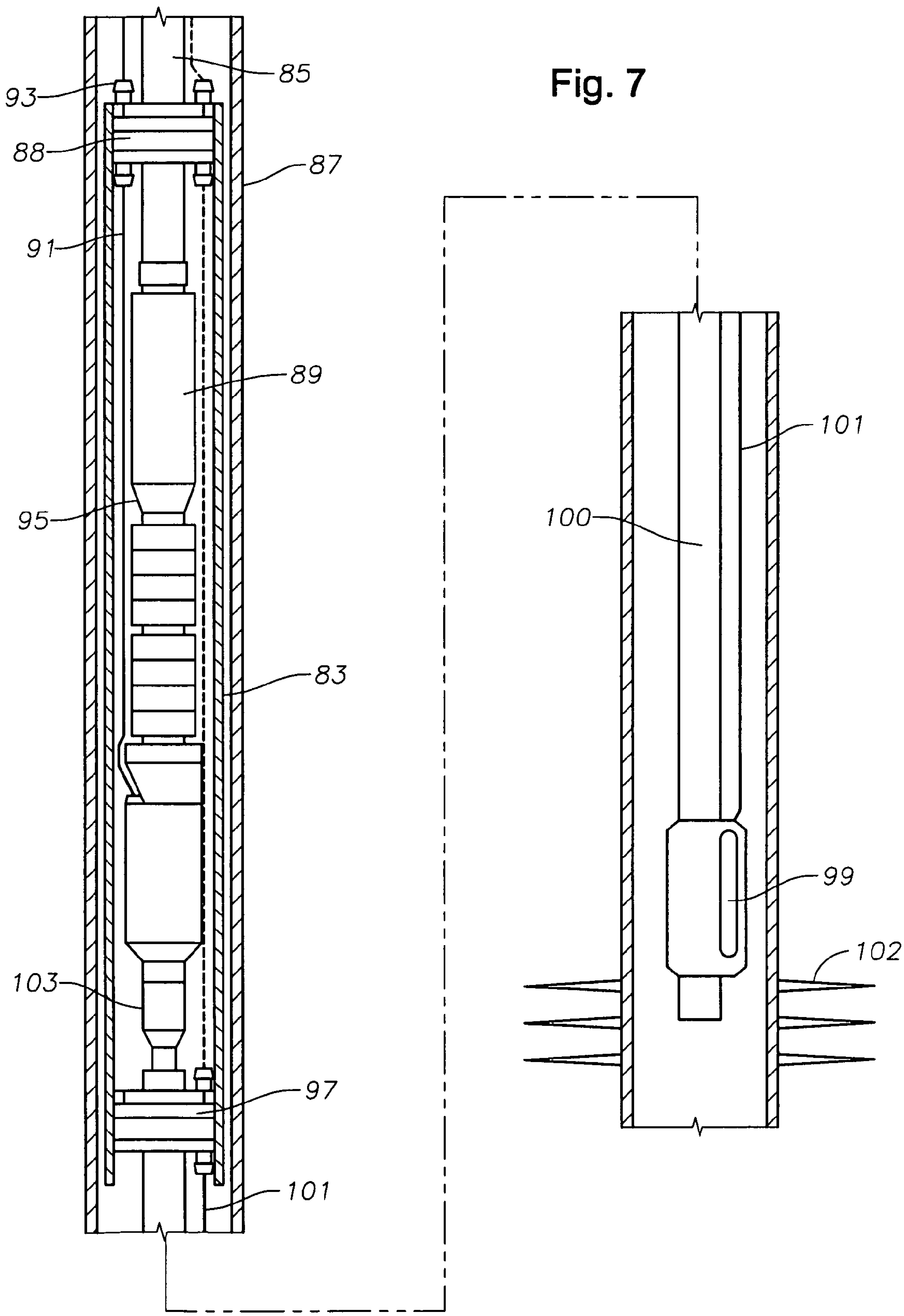

Fig. 7

CAPSULE FOR TWO DOWNHOLE PUMP MODULES

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority to provisional application 60/802,626, filed May 23, 2006.

FIELD OF THE INVENTION

This invention relates in general to an electrical submersible pump (ESP) and in particular to a downhole capsule containing two ESP modules.

BACKGROUND OF THE INVENTION

An electrical submersible pump ("ESP") assembly for wells typically comprises a submersible motor that drives a pump, typically a centrifugal pump. The pump assembly is usually suspended on a string of tubing within the well. The power cable to the motor is strapped alongside the tubing. Periodically, the pump assembly has to be retrieved for maintenance or repair, and this step requires pulling the tubing. Pulling the tubing requires a workover rig and is time consuming, particularly for offshore installations.

In some cases a dual tandem pump assembly is used to provide more lift. Normally two pumps are connected together and driven by a single motor. The pumps thus operate in unison with each other. Repair or replacement of either pump requires pulling the tubing and the entire assembly.

Often a pressure and temperature sensor will be mounted to the base of the motor for sensing the pressure and temperature of the dielectric liquid within the motor. The power to the motor fluid sensor and the signals are superimposed on the ESP power cable. Another measuring tool comprises a reservoir sensor, which is an electrical device that senses various characteristics of the producing reservoir of the well on the exterior of the motor. These tools typically send signals up a dedicated communication line extending to the surface.

SUMMARY

In this invention a capsule having an upper end for connection to a string of production tubing is lowered within casing of a well. An electrical submersible pump assembly is located within and suspended by the upper end of the capsule. A bulkhead is located within the capsule below the pump assembly. An electrically powered device is suspended by and below the bulkhead. A power lead extends from the electrically powered device through the bulkhead, alongside the pump assembly within the capsule and sealingly through the upper end of the capsule. The electrically powered device may be suspended below the capsule or contained within the capsule.

The electrically powered device may be a sensor for sensing reservoir characteristics or it may be a second submersible pump assembly. In one embodiment having two ESP's, the bulkhead divides the capsule into upstream and downstream chambers, each chamber containing one of the pump assemblies. The power cables for each motor pass through the capsule alongside the outlet. The two submersible pump assemblies may operate simultaneously or one may operate while the other is shut down.

The reservoir sensor unit may be suspended below the hanger or bulkhead. The power and signals for the reservoir sensor unit may be supplied via a dedicated sensor line to the surface, or the sensor line may only extend to the motor sensor. In the latter case, the reservoir sensor and the motor sensor may be superimposed on the ESP power cable.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. **1**A and **1**B comprise a vertical sectional view of a capsule containing two ESP modules in accordance with this invention.

FIG. **2** is an enlarged sectional view of the lower hanger contained within the capsule of FIG. **1**.

FIG. **3** is an alternate embodiment of the lower hanger contained in the capsule of FIG. **1**.

FIG. **4** is a schematic view illustrating both ESP's of the capsule of FIG. **1** operating.

FIG. **5** is a schematic view illustrating the upper ESP of the capsule of FIG. **1** operating and the lower ESP not operating.

FIG. **6** is a schematic view illustrating the lower ESP of the capsule of FIG. **1** operating and the upper ESP not operating.

FIG. **7** is a vertical sectional view of an alternate embodiment of a capsule, wherein one of the ESP modules of the capsule is a downhole sensor assembly.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. **1**, a well having a casing **11** is illustrated. Casing **11** is perforated at its lower end for allowing well fluid to enter. A string of production tubing **13** is suspended within casing **11**. A capsule **15** is secured to a lower end of tubing **13**.

Capsule **15** is a cylindrical member of slightly smaller outer diameter than the inner diameter of casing **11** so that it can be lowered into casing **11** on tubing **13**. Capsule **15** has an upper or downstream end with a hanger **17** that is rigidly secured to the lower end of tubing **13**.

An optional upper or downstream sleeve valve **19** is secured into a downstream conduit **18** below upper hanger **17**. Upper sleeve valve **19** has an interior that is communication with the interior of tubing **13** for discharging well fluid upward. Upper sleeve valve **19** has an open position in which ports **21** on its sidewall are exposed to the interior of capsule **15**. Upper sleeve valve **19** has a closed position in which ports **21** are closed to the interior of capsule **15**.

An upper or downstream ESP **23** is suspended on upper sleeve valve **19**. Upper sleeve valve **19** may be a commercially available type that closes its ports **21** to the interior of capsule **15** when downstream ESP **23** is operating. When ESP **23** is not operating, upper sleeve valve **19** automatically opens its ports **21** to the interior of capsule **15**. This type of valve, known as an annulus diverter valve, is used normally in tubing above submersible pumps in applications that are prone to significant sand production. Alternately, upper sleeve valve **19** could be hydraulically actuated or stroked between the open and closed positions by pressure supplied from the surface via a hydraulic line **24** that extends alongside tubing **13** and sealingly through upper hanger **17**.

If upper sleeve valve **19** is not utilized, upper ESP **23** would connect directly to upper hanger **17**. Upper ESP **23** is a conventional electrical submersible pump assembly, including a centrifugal pump **25**, which is shown at the upper end of the assembly. Pump **25** has an intake **26** on its lower end and is made up of a large number of stages or impellers and diffusers. One or more seal sections **27** are connected to the lower end of pump **25**. An electrical motor **29** is connected to the lower end of the seal section or sections **27**. Motor **29** is preferably a three-phase alternating current motor. Motor **29** is filled with lubricant, and seal sections **27** equalize the interior pressure of the lubricant in motor **29** with the pressure in capsule **15**.

Motor **29** has an electrical power lead **31** that extends upward alongside seal section **27** and pump **25** within capsule **15**. Motor lead **31** extends through an upper penetrator or guide **33** in upper hanger **17**. Upper penetrator **33** seals motor lead **31** in upper hanger **17**. Above capsule **15**, motor lead **31** joins a power cable (not shown) that is strapped alongside tubing **13** and extends to the surface.

A lower extension pipe **35** extends from the lower end of motor **29** to a lower hanger or bulkhead **37** located within capsule **15**. Lower hanger **37** is sealed to the sidewall of capsule **15**, defining an upper or downstream chamber **36** above lower hanger **37** and a lower or upstream chamber **38** below lower hanger **37**. A downstream conduit or support tube **39** secured to the lower side of lower hanger **37** is illustrated in FIG. **1**B. An optional sliding sleeve valve **41** is connected to the lower end of support tube **39**. Sliding sleeve valve **41** has ports **43** that lead to the interior of capsule **15** and may be of the same type of valve as upper sliding sleeve valve **19**.

A lower or upstream ESP **45** is secured to the lower end of lower sliding sleeve valve **41**, and its weight is supported by upper hanger **17** through upper ESP **23** in this embodiment. Sleeve valve **41** also may be an annulus diverter type that automatically closes ports **43** when lower ESP **45** is operating and opens ports **43** when ESP **45** is not operating. Alternately, sleeve valve **41** could open and close ports **43** in response to hydraulic fluid pressure supplied from a line **44** extending to the surface. If desired, lower sliding sleeve valve **41** may be operated independently of upper sleeve valve **19** by a separate hydraulic line from the hydraulic line leading to upper sleeve valve **19**. Alternatively, a single hydraulic line could control both sleeve valves **19**, **41**. For example, if lower ESP **45** is a back up to be operated only after upper ESP **23** fails, sleeve valve **41** could be connected to the same hydraulic line as upper sleeve valve **19** and operated in reverse to upper sleeve valve **19**. That is, while only upper ESP **23** is operating, as illustrated in FIG. **5**, the hydraulic pressure in the hydraulic line to sleeve valves **19**, **41** keeps sleeve valve **19** closed and sleeve valve **41** open. When upper ESP **23** is shut down and lower ESP **45** started, the hydraulic pressure in the line to valves **19**, **41** would be reversed by an operator at the surface to open upper sleeve valve **19** and close lower sleeve valve **41**, as shown in FIG. **6**.

If a lower sleeve valve **41** is not utilized, lower ESP **45** will be secured directly to support tube **39**. Lower ESP **45** may be the same type as upper ESP **23**, although it may be of a different length, if desired. Lower ESP **45** includes a centrifugal pump **47** with an intake **48**. Discharge port **50** of lower ESP **45** is in extension pipe **35** in upper chamber **36**. One or more seal sections **49** connect pump **47** to electrical motor **51**. A motor lead **53** extends from the upper end of motor **51** through a lower hanger penetrator **55** in lower hanger **37**. Penetrator **55** seals motor lead **53** within lower hanger **37**. Lower ESP motor lead **53** extends alongside upper ESP **23** and through an upper penetrator **56** located within upper hanger **17** to a power cable (not shown) extending to the surface. Capsule **15** has an inlet **59** located below the lower end of lower ESP **45**. Inlet **59** communicates well fluid in casing **11** to lower chamber **38** surrounding lower ESP **45**. Optionally inlet **59** comprises a stinger that stabs into a packer (not shown). The packer isolates the well fluid below it from the fluid within casing **11** surrounding capsule **15** and production tubing **13**.

FIG. **2** illustrates a first embodiment of bulkhead or lower hanger **37**. In this embodiment, lower hanger **37** has seals **61** that seal against a polished bore **63** on the inner diameter of capsule **15**. Hanger **37**, along with seals **61**, is able to slide axially along polished bore **63** as indicated by the arrows. This axial movement of lower hanger **37** accommodates thermal growth of upper ESP **23** (FIG. **1**A) during operation. Lower ESP **45** is able to grow thermally because its lower end is spaced above capsule inlet **59** and is free to move. The entire weight of both upper and lower ESP's **23**, **45** is supported by upper hanger **17** in the embodiment of FIG. **2**.

In the embodiment of FIG. **3**, capsule **65** differs from capsule **15** of the first embodiment in that it has a load shoulder **67** located on the inner diameter. Lower hanger **69** lands on load shoulder **67** so as to support the weight of lower ESP **45** (FIG. **1**B). Lower hanger **69** has seals **71** that statically engage a seal surface on the inner diameter of capsule **65** above load shoulder **67**.

To accommodate thermal growth of upper ESP **23** (FIG. **1**A) in the embodiment of FIG. **3**, a telescoping joint is utilized for connecting between lower hanger **69** and the assembly of ESP **23** (FIG. **1**A). This telescoping joint includes an upward facing receptacle **73** in this example. Receptacle **73** is open at its upper end and slidingly receives a tubular mandrel **75** that is rigidly secured to the lower end of upper ESP **23** (FIG. **1**A). Mandrel **75** has seals **77** that will slidingly engage a seal surface within receptacle **73**. Upper and lower stops **79**, **81** limit the travel of mandrel **75** relative to receptacle **73** during installation of ESP **23** in capsule **65**. Receptacle **73** and mandrel **75** could alternately be reversed with mandrel **75** mounted to hanger **69** and receptacle **73** mounted to the lower end of upper ESP **23**. Discharge port **82** from lower ESP **45** (FIG. **1**B) is located in mandrel **75**.

In a third embodiment (not shown), instead of lower hanger **37** (FIG. **2**) or **69** (FIG. **3**), the bulkhead would be a packer that is conventionally actuated to expand, grip and seal to the inner surface of capsule **15**. In that embodiment, the packer would support the weight of lower ESP **45** and would not be movable either upward or downward in capsule **15**.

In operation, upper and lower ESP'S **23**, **45** are installed within capsule **15** while at the surface. The entire assembly then is lowered into the well on tubing **13**. The upper ends of motor leads **31**, **53** are connected to power cables (not shown), which are strapped alongside tubing **13**. While being lowered, capsule **15** protects motor leads **31** and **53** against damage in the areas where they pass alongside upper seal section **27** and upper pump **25**. Because both motor leads **31** and **53** pass alongside these components, the clearance within casing **11** can be quite small.

Once capsule **15** is at the desired depth, the operator has a choice of simultaneously operating both upper and lower ESP's **23**, **45** as shown in FIG. **4**, operating only the upper ESP **23** as shown in FIG. **5**, or operating only the lower ESP **45** as shown in FIG. **6**. To operate both ESP's **23**, **45** simultaneously, the operator supplies power to both motors **29**, **51** (FIG. **1**) and both upper and lower sleeve valves **19**, **41** are closed, either automatically or by hydraulic pressure supplied from the surface. In fact, if the operator intends to always operate both ESP's **23**, **45** simultaneously, sleeve valves **19**, **41** are not required.

In the booster mode of FIG. **4**, well fluid flows through capsule inlet **59** into lower chamber **38** and lower pump intake **48**. Lower ESP **45** increases the pressure of the well fluid and discharges it from lower pump discharge port **50** into upper chamber **36** of capsule **15**. The higher pressure in upper chamber **36** is isolated by lower hanger **37** from the intake pressure in lower chamber **38**. The higher pressure fluid enters upper pump intake **26**, which boosts the pressure and discharges the well fluid into production tubing **13**. In this mode, ESP's **23**, **45** operate in series.

As illustrated in FIG. **5**, in this mode, only upper ESP **23** operates. To avoid flowing well fluid through the stages of the non operating pump of lower ESP **45**, lower sleeve valve **41** is opened. Opening lower sleeve valve **41** could be done by hydraulic fluid pressure. Alternately, if automatic sleeve valves **19**, **41** are used, merely supplying power to upper ESP **23** while not supplying power to lower ESP **45** will cause lower sleeve valve **41** to open while upper sleeve valve **19** remains closed. In this mode, the well fluid bypasses the pump of lower ESP **45**, flows from lower chamber **38** into the ports of lower sleeve valve **41** and discharges out lower pump discharge port **50** into upper chamber **36** of capsule **15**. The pressure in upper chamber **36** is substantially the same as at capsule inlet **59**. The well fluid flows into upper pump intake **26**, which discharges it at a higher pressure into tubing **13**.

Referring to FIG. **6**, in this mode, upper ESP **23** is not operating, rather only lower ESP **45**. This mode might occur after upper ESP **23** failed, in which case lower ESP **45** is energized as a back up. Upper sliding valve **19** is opened, and lower sliding valve **41** is closed, either by hydraulic fluid pressure or by automatic valves, as discussed. The well fluid flows from lower chamber **38** into lower pump intake **48** and is discharged out lower pump discharge **50** in upper chamber **36** at a higher pressure. The well fluid flows into the open ports of upper sleeve valve **19** rather than flowing through the stages of the pump of upper ESP **23**. The well fluid is discharged into tubing **13** at substantially the same pressure that it was discharged from lower ESP discharge **50**.

In another embodiment, which isn't shown, the lower end of capsule **15** terminates at lower hanger **37**. Lower ESP **45** is not located within capsule **15**, but is suspended by lower hanger **37**. Lower ESP **45** may have a tail pipe or stinger in that instance that would sting into a packer (not shown).

Referring to FIG. **7**, an alternate embodiment is shown wherein only one ESP is utilized. In this embodiment, capsule **83** is suspended on a string of production tubing **85** within casing **87**. ESP **89** is supported by an upper hanger **88**, which in turn is connected to tubing **85**. A motor lead **91** extends sealingly through a penetrator **93** in upper hanger **88** and down to the motor of ESP **89**. ESP **89** has a pump intake **95**, which is in capsule **83**. A hanger or bulkhead **97** is located at the lower end of ESP **89**. Hanger **97** may be constructed as in either the first embodiment of FIG. **2** or the second embodiment of FIG. **3**, or it could be a packer.

In this embodiment, the lower end of capsule **83** terminates at lower hanger **97**. In this example, a downhole sensor **99** is suspended on a tubular member or stinger **100** that is mounted to lower hanger **97**. Sensor **99** is a conventional electrical device that senses various characteristics of the reservoir, such as pressure and water/oil contact, and will be referred to herein as a reservoir sensor. Tubular member **100** has a length selected to place reservoir sensor **99** close to perforations **102** of the reservoir. The well fluid flows upward through tubular member **100** into the interior of capsule **83** and into pump intake **95**. Tubular member **100** could sting into a packer, if desired.

Optionally ESP **89** also has a conventional ESP motor sensor **103** mounted at its base. ESP sensor **103** measures parameters of the well fluid inside capsule **83**, such as intake and discharge pressure, motor temperature and vibration. ESP sensor **103** is connected electrically to the motor of ESP **89**, and the signal of ESP sensor **103** may be sent via ESP motor lead **91** and power cable to the surface. At the surface, circuitry separates the signal of ESP sensor **103** from the electrical power and provides a display.

If such an ESP sensor **103** is utilized, preferably a sensor lead **101** leads from reservoir sensor **99** alongside conduit **100** and sealingly through lower hanger **97** to ESP sensor **103**. In that way, the signal from reservoir sensor **99** is also superimposed on motor lead **91** and the power cable for reception at the surface. Alternately, reservoir sensor lead **101** could extend through upper hanger **88** and alongside tubing **85** to the surface as indicated by the dotted lines in FIG. **7**, and ESP sensor **103** could transmit its signals in a conventional manner on the power cable. If an ESP sensor **103** is not utilized, the signals for reservoir sensor **99** would preferably be communicated through reservoir sensor lead **101** to the surface.

Although not shown, a dual ESP system could be employed in which the lower ESP is not located within a capsule, but is suspended below the capsule containing the upper ESP. This system could particularly be employed when a packer is not required. In addition, the capsule could be located within a subsea flowline rather than within a well, in which case the ESP or ESP's would be oriented approximately horizontal.

The invention has significant advantages. In the dual ESP environment, the operator can use one ESP until it breaks down, then operate with the second ESP. This substitution extends the time before the tubing must be pulled. The capsule supports the weight of the lower ESP or a downhole reservoir sensor, rather than imposing a load on the upper ESP. If desired, the dedicated line normally used for a downhole reservoir sensor could be eliminated and signals superimposed on the ESP power cable.

While the invention has been shown in only a few of its forms, it should be apparent to those skilled in the art that it is not so limited but is susceptible to various changes without departing from the scope of the invention.

The invention claimed is:

1. A well pumping apparatus, comprising:

a capsule having an upper end for connection to a string of production tubing lowered within casing of a well;

an upper pump assembly including a pump and a motor located within and suspended by the upper end of the capsule;

an upper motor lead extending from the motor alongside the pump within the capsule and sealingly through the upper end of the capsule;

a bulkhead within the capsule below the upper pump assembly and above a lower end of the capsule;

lower pump assembly including a pump and a motor located within the capsule below the bulkhead; and

a lower motor lead extending from the motor of the lower pump assembly through the bulkhead;

the bulkhead sealingly engaging the capsule, defining an upper chamber and a lower chamber within the capsule;

the upper pump assembly having an intake in the upper chamber and a discharge conduit connected to the upper end of the capsule;

the lower pump assembly having an intake in the lower chamber and a discharge conduit connected to the bulkhead, the discharge conduit leading through the bulkhead into the upper chamber; and

a discharge port located in the discharge conduit of the lower pump assembly and in the upper chamber.

2. The apparatus according to claim **1**, wherein the bulkhead is connected to and supported by the upper pump assembly.

3. The apparatus according to claim 2, wherein:

the bulkhead has an outer diameter portion that sealingly engages an inner diameter portion of the capsule, and

the bulkhead is axially movable relative to the capsule in response to thermal growth of the upper pump assembly during operation.

4. The apparatus according to claim 1, wherein:

the bulkhead is mounted within the capsule to prevent downward movement relative to the capsule; and

a telescoping joint connects a lower end of the pump assembly to the bulkhead to allow thermal growth of the pump assembly relative to the bulkhead.

5. The apparatus according to claim 1, further comprising:

an upper sleeve valve in the discharge conduit of the upper pump assembly in the upper chamber for selectively opening and closing communication of the discharge conduit of the upper pump assembly to the upper chamber; and

a lower sleeve valve in the discharge conduit of the lower pump assembly within the lower chamber for selectively opening and closing communication of the discharge conduit of the lower pump assembly to the lower chamber.

6. The apparatus according to claim 5, wherein:

the apparatus has a first mode of operation in which both of the pump assemblies are operating and both sleeve valves are closed;

the apparatus has a second mode of operation in which only the upper pump assembly is in operation, the upper sleeve valve is closed, and the lower sleeve valve is open; and

the apparatus has a third mode of operation in which only the lower pump assembly is operating, and the lower sleeve valve is closed and the upper sleeve valve is open.

7. The apparatus according to claim 5, further comprising:

at least one hydraulic line extending sealingly through an upper end of the capsule to the upper sleeve valve and sealingly through the bulkhead to the lower sleeve valve for selectively opening and closing the upper and lower sleeve valves.

8. A well fluid pumping apparatus, comprising:

a capsule having an inlet for receiving well fluid and an outlet for discharging well fluid;

upstream and downstream pump assemblies located within the capsule, each having a pump and a submersible electrical motor,

a bulkhead within the capsule between the upstream and downstream pump assemblies, dividing the capsule into upstream and downstream chambers sealed from each other, an intake of the upstream pump assembly being in the upstream chamber, an intake of the downstream pump assembly being in the downstream chamber, the inlet of the capsule being in communication with the upstream chamber;

an upstream conduit extending from a discharge of the upstream pump assembly through the bulkhead into the downstream chamber;

a downstream conduit connected between a discharge of the downstream pump assembly and the outlet of the capsule; and

the upstream and downstream pump assemblies having a dual operation mode wherein well fluid flows through the inlet of the capsule into the upstream chamber, is pumped to a first pressure level by the upstream pump assembly and discharged through the upstream conduit into the downstream chamber, then pumped to a second pressure level by the downstream pump assembly and discharged through the downstream conduit out the outlet of the capsule.

9. The apparatus according to claim 8, further comprising:

an upstream port within the upstream chamber in the upstream conduit;

an upstream valve that selectively opens and closes the upstream port, the upstream valve being closed while the upstream and downstream pump assemblies are in the dual mode; and

the upstream and downstream pump assemblies having a downstream pump assembly only mode of operation, wherein the upstream pump assembly ceases operation, the upstream valve is opened, and well fluid flows through the inlet of the capsule into the upstream chamber, through the upstream port and out the upstream conduit into the downstream chamber, then is pumped by the downstream pump assembly out the outlet of the capsule.

10. The apparatus according to claim 9, further comprising:

at least one hydraulic line extending sealingly through an upper end of the capsule and the bulkhead to the upstream valve for selectively opening and closing the upstream valve.

11. The apparatus according to claim 8, further comprising:

a downstream port within the downstream chamber in the downstream conduit;

a downstream valve that selectively opens and closes the downstream port, the downstream valve being closed while the upstream and downstream pump assemblies are in the dual mode; and

the upstream and downstream pump assemblies having an upstream pump assembly only mode of operation, wherein the downstream pump assembly ceases operation, the downstream valve is opened, and well fluid flows through the inlet of the capsule into the upstream chamber, and is pumped by the downstream pump through the upstream conduit into the downstream chamber, then through the downstream port into the downstream conduit and out the outlet of the capsule.

12. The apparatus according to claim 11, further comprising:

at least one hydraulic line extending sealingly through an upper end of the capsule to the downstream valve for selectively opening and closing the downstream valve.

13. The apparatus according to claim 8, further comprising:

an upstream port within the upstream chamber in the upstream conduit;

an upstream valve that selectively opens and closes the upstream port, the upstream valve being closed while the upstream and downstream pump assemblies are in the dual mode;

a downstream port within the downstream chamber in the downstream conduit;

a downstream valve that selectively opens and closes the downstream port, the downstream valve being closed while the upstream and downstream pump assemblies are in the dual mode;

the upstream and downstream pump assemblies having a downstream pump assembly only mode of operation, wherein the upstream pump assembly ceases operation, the upstream valve is opened and the downstream valve closed, and well fluid flows through the inlet of the capsule into the upstream chamber, through the upstream port and out the upstream conduit into the downstream chamber, then is pumped by the downstream pump assembly out the outlet of the capsule; and

the upstream and downstream pump assemblies having an upstream pump assembly only mode of operation, wherein the downstream pump assembly ceases operation, the downstream valve is opened and the upstream valve is closed, and well fluid flows through the inlet of the capsule into the upstream chamber, and is pumped by the upstream pump through the upstream conduit into the downstream chamber, then through the downstream port into the downstream conduit and out the outlet of the capsule.

14. The apparatus according to claim **13**, wherein:

the upstream and downstream valves are biased to an open position;

operation of the upstream pump causes the upstream valve to close; and

operation of the downstream pump causes the downstream valve to close.

15. The apparatus according to claim **8**, wherein:

the bulkhead has an outer diameter portion that sealingly engages an inner diameter portion of the capsule, and

the bulkhead is axially movable relative to the capsule in response to thermal growth of the pump assembly during operation.

16. The apparatus according to claim **8**, wherein:

the bulkhead is fixed in the capsule to prevent downward movement of the bulkhead relative to the capsule; and

a telescoping joint connects an end of the downstream pump assembly to the bulkhead to allow thermal growth of the downstream pump assembly relative to the bulkhead.

17. A method of pumping a well fluid, comprising:

(a) mounting upstream and downstream pump assemblies within a capsule, each having a pump and a submersible electrical motor, the capsule having a bulkhead between the upstream and downstream pump assemblies, dividing the capsule into upstream and downstream chambers sealed from each other, an intake of the upstream pump assembly being in the upstream chamber, an intake of the downstream pump assembly being in the downstream chamber; and

(b) operating the upstream and downstream pump assemblies in a dual operation mode, causing well fluid to flow through an inlet of the capsule into the upstream chamber where the well fluid is pumped by the upstream pump assembly and discharged through the bulkhead into the downstream chamber, wherein the well fluid is pumped by the downstream pump assembly and discharged out an outlet of the capsule.

18. The method according to claim **17**, wherein step (b) further comprises:

operating in a downstream pump assembly only operation by ceasing operation of the upstream pump, and flowing the well fluid from the inlet of the capsule directly to the downstream chamber, thereby bypassing the upstream pump assembly.

19. The method according to claim **17**, wherein step (b) further comprises:

operating in an upstream pump assembly only operation by ceasing operation of the downstream pump, and flowing the well fluid from the inlet of the capsule and from the upstream pump assembly directly to the downstream chamber and out the outlet of the capsule, thereby bypassing the downstream pump assembly.

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,736,133 B2
APPLICATION NO. : 11/750014
DATED : June 15, 2010
INVENTOR(S) : Ignacio Martinez

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

Column 2, line 38, insert --in-- before “communication”
Column 6, line 49, insert --a-- before “lower pump”
Column 6, line 50, delete “and”

Signed and Sealed this

Sixteenth Day of November, 2010

David J. Kappos

Director of the United States Patent and Trademark Office